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(54) **INTELLIGENT VEHICLE LOAD MEASURING SYSTEM AND METHOD**

(75) Inventor: **Yuan-Lin Chen**, 84 Gungjuan Rd., Taishan, Taipei Hsien (TW)

(73) Assignee: **Yuan-Lin Chen**, Taishan (TW)

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G01G 19/14 (2006.01)

(52) **U.S. Cl.** **702/174**

(58) **Field of Classification Search** 702/174; 701/50; 280/5.514
See application file for complete search history.

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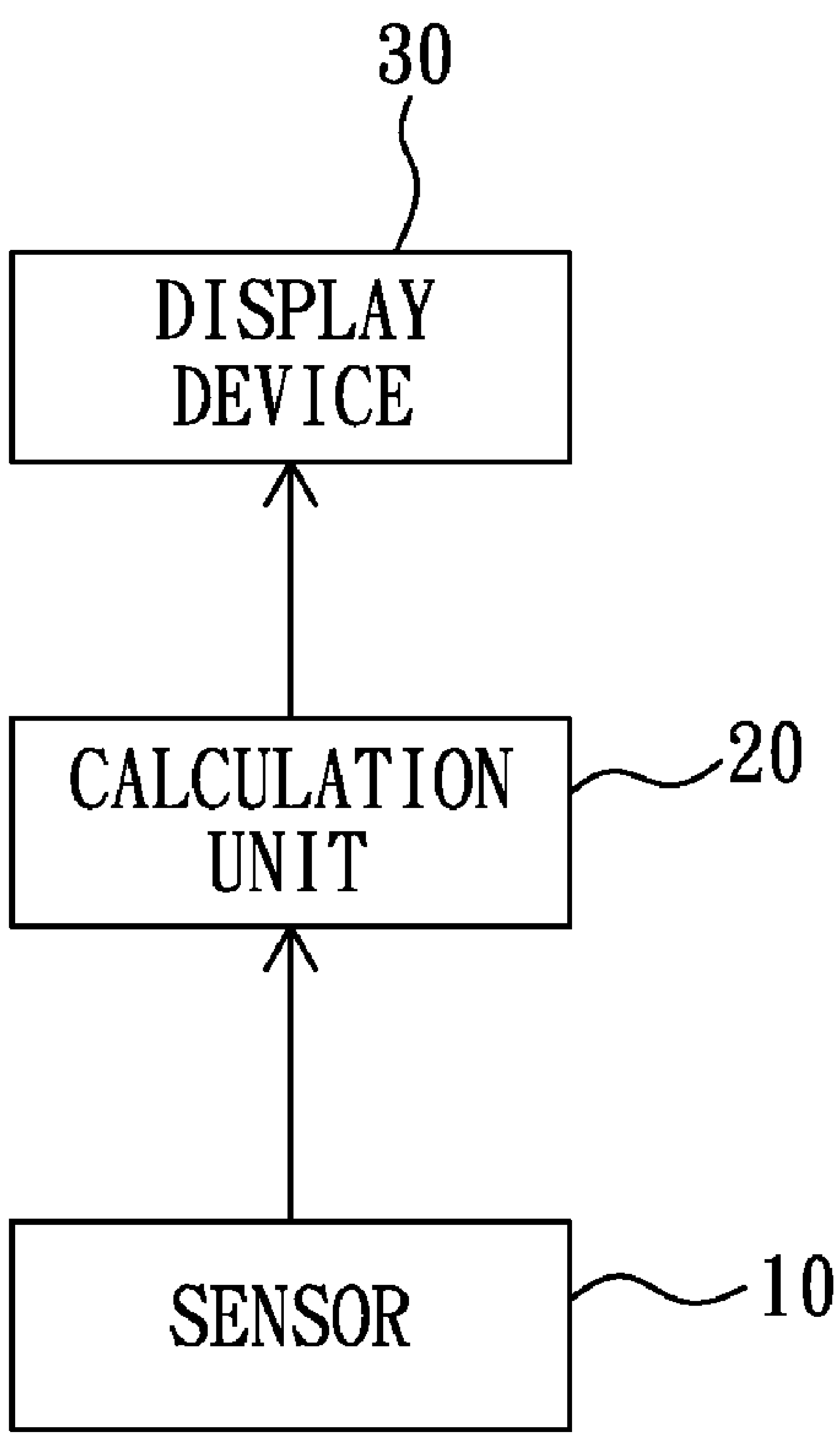
Primary Examiner—Tung S Lau
Assistant Examiner—Xiuquin Sun
(74) *Attorney, Agent, or Firm*—Guice Patents PLLC

(57) **ABSTRACT**

An intelligent vehicle load measuring system includes a sensor installed in the shock-absorber of every wheel of a vehicle to detect the extension length data of the associating shock-absorber when the vehicle carries a load, a calculation unit coupled to the sensors to receive the extension length data of every shock-absorber of the vehicle and to calculate the weight of the load received by each shock-absorber and the total weight and loadage of the vehicle, and a display unit electrically coupled to the calculation unit to display the load data of the vehicle. The invention involves also an intelligent vehicle load measuring method.

17 Claims, 4 Drawing Sheets



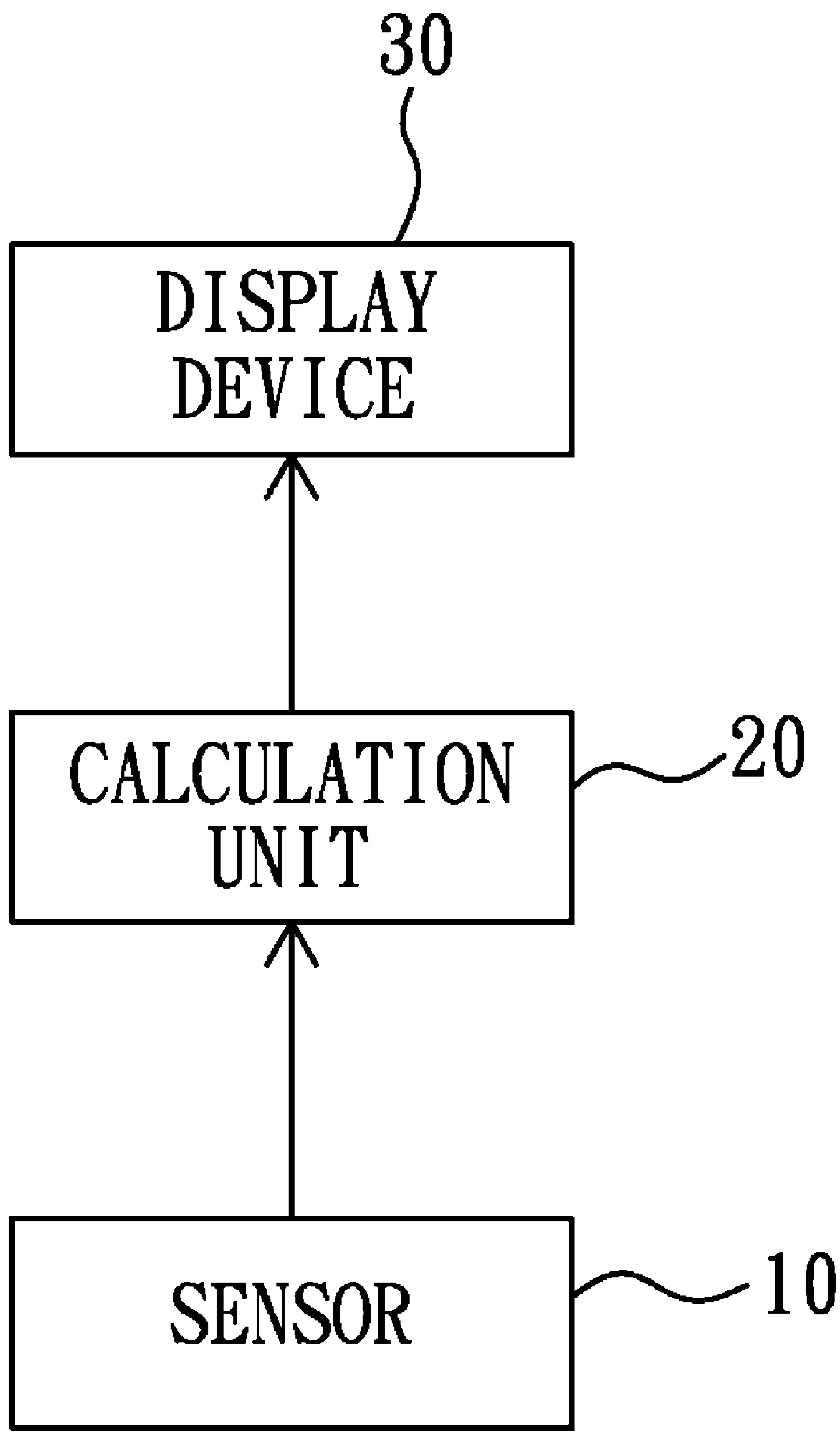


FIG. 1

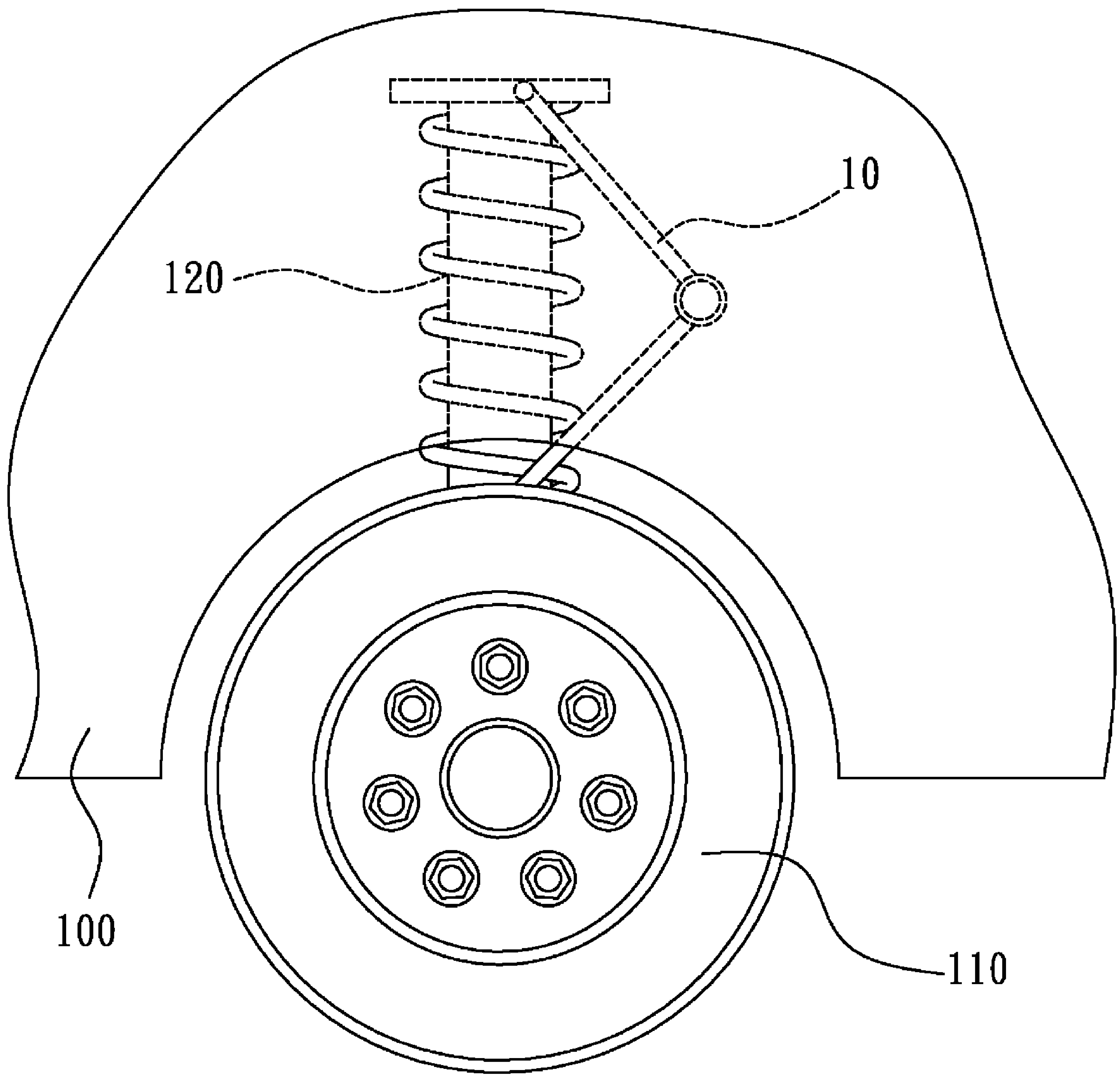


FIG. 2

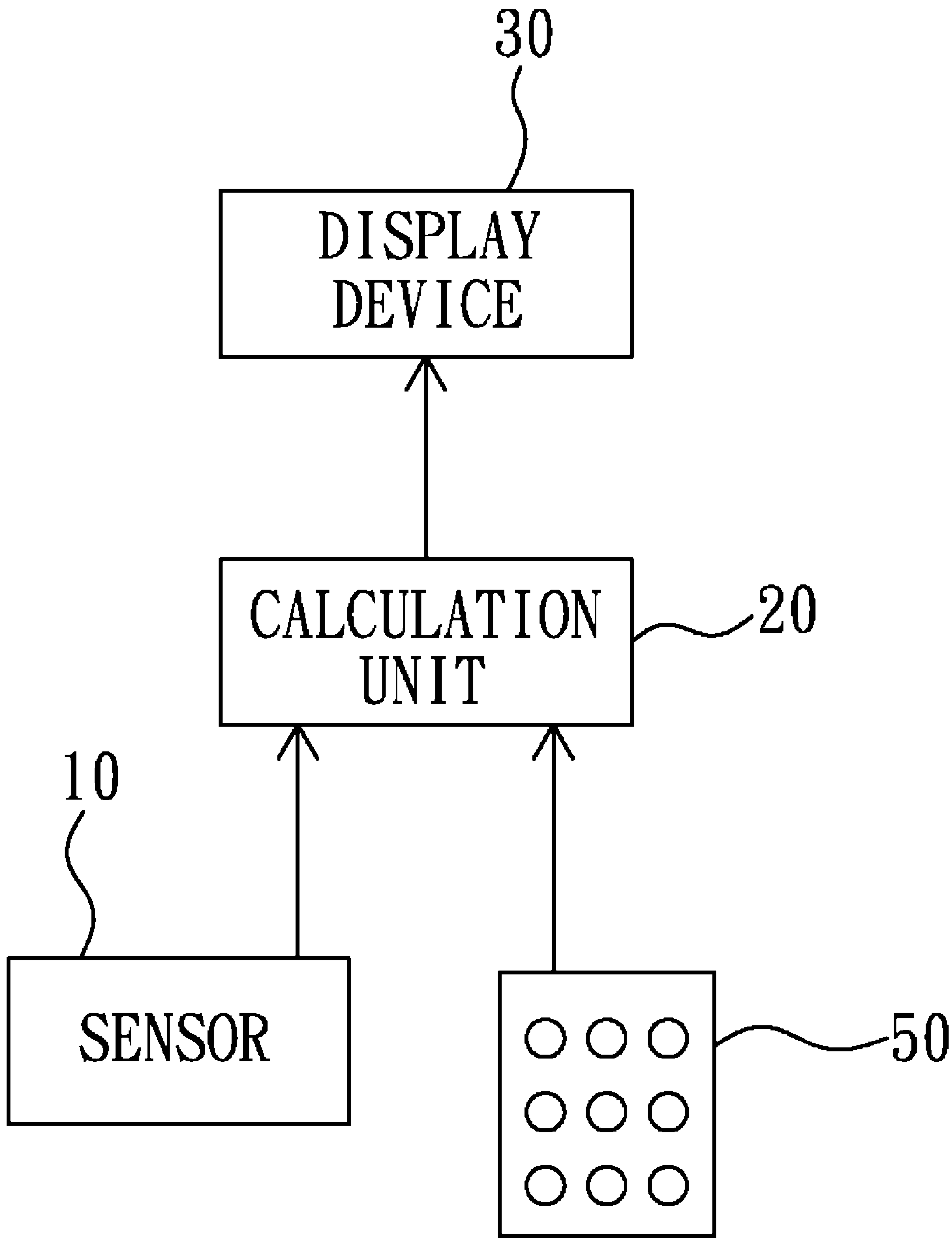


FIG. 3

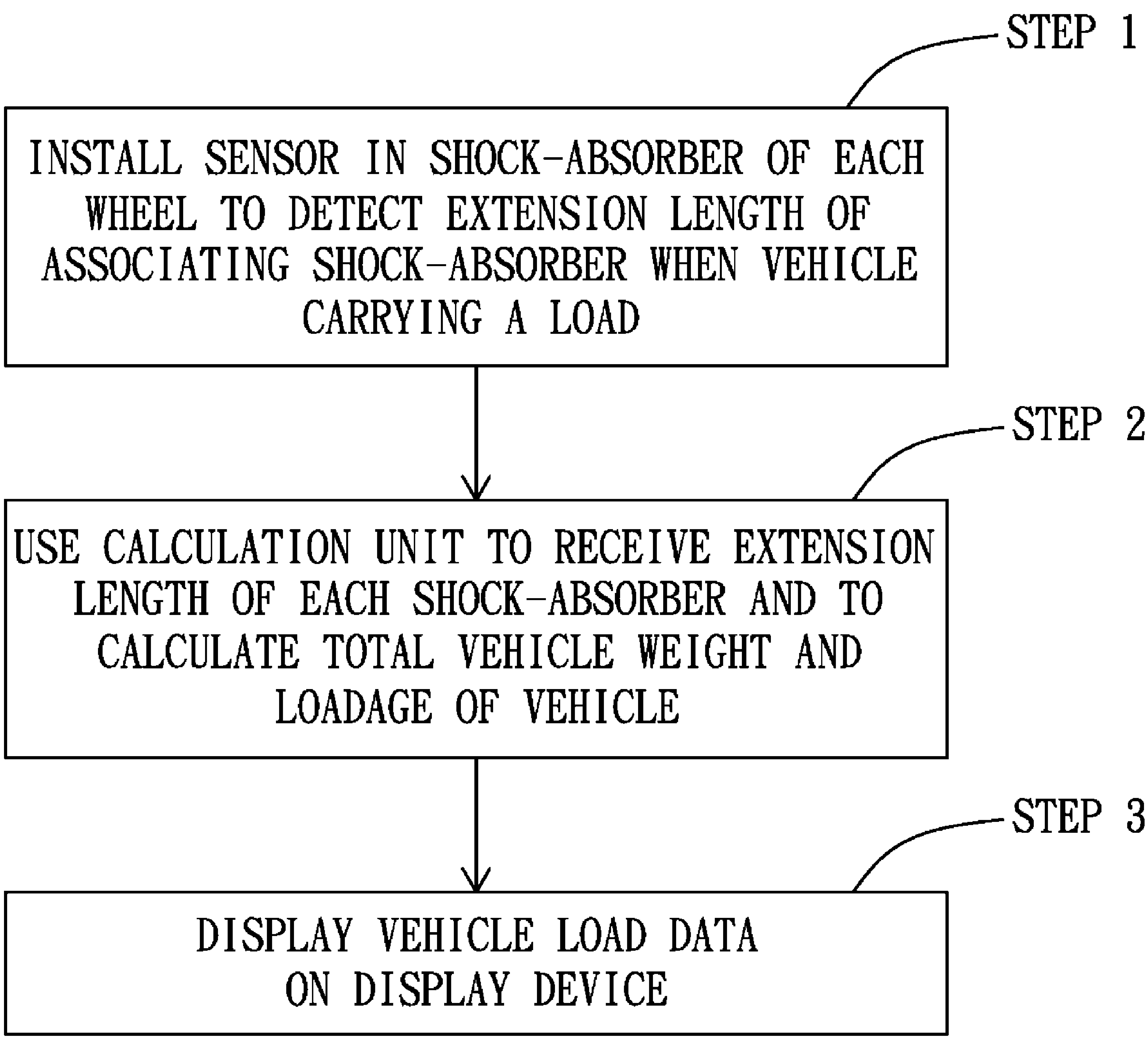

STEP 1
INSTALL SENSOR IN SHOCK-ABSORBER OF EACH WHEEL TO DETECT EXTENSION LENGTH OF ASSOCIATING SHOCK-ABSORBER WHEN VEHICLE CARRYING A LOAD
STEP 2
USE CALCULATION UNIT TO RECEIVE EXTENSION LENGTH OF EACH SHOCK-ABSORBER AND TO CALCULATE TOTAL VEHICLE WEIGHT AND LOADAGE OF VEHICLE
STEP 3
DISPLAY VEHICLE LOAD DATA ON DISPLAY DEVICE

FIG. 4

INTELLIGENT VEHICLE LOAD MEASURING SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vehicle load measuring system and more particularly, to an intelligent vehicle load measuring system, which has a sensor respectively installed in the shock-absorber of every wheel of a vehicle to detect the extension length data of the associating shock-absorber and utilizes a calculation unit to receive the extension length data of every shock-absorber and to calculate the weight of the load received by every shock-absorber and the total weight and loadage of the vehicle for enabling the calculated vehicle load data to be displayed on a display device. The invention relates also to an intelligent vehicle load measuring method.

2. Description of the Related Art

A vehicle (motorcycle, sedan, bus, truck, towing vehicle, etc.) has a load limit. Overloading a vehicle can significantly impair the driver's ability to steer correctly. Incorrect steering of a vehicle may cause traffic accidents or road damage. Therefore, traffic police department strictly enforces overloading regulations, preventing the occurrence of accidents.

A vehicle driver cannot know whether or not the vehicle (truck or towing vehicle) is overloaded unless the vehicle is measured through a floor weight scale. If a vehicle is overloaded, the driver will be charged for a fine. Further, overloaded vehicles threaten road safety and are contributing to many of fatal accidents on the roads.

Further, a vehicle driver cannot easily know the condition of the shock-absorbers of the vehicle. Any shock-absorber problem may be discovered only when the damage is serious or the vehicle is receiving a routine check. Because a vehicle shock-absorber is expensive, a bad mechanic may convince a driver to replace the shock-absorbers of the vehicle that are not seriously damaged.

Therefore, it is desirable to provide an intelligent vehicle load measuring system and method capable of recording the dynamic load curve of the shock-absorbers of the vehicle and the maximum transient load on each wheel during steering of the vehicle for reference by the driver and for further analysis to check the condition of the shock-absorbers. Measuring vehicle load at the same time can remind the driver to get rid of unnecessary weight to achieve the purpose of fuel-saving.

SUMMARY OF THE INVENTION

The present invention has been accomplished under the circumstances in view. It is the main object of the present invention to provide an intelligent vehicle load measuring system and method for measuring the total weight and loadage of a vehicle by means of using sensors to detect the extension length of every shock-absorber of the vehicle and a calculation unit to calculate the total weight and loadage of the vehicle for display on a display device.

To achieve this and other objects of the present invention, the intelligent vehicle load measuring system comprises at least one sensor respectively installed in the shock-absorber of every wheel of a vehicle to detect the extension length data of the shock-absorber of every wheel of the vehicle when the vehicle carries a load; a calculation unit coupled to the at least one sensor to receive the extension length data of the shock-absorber of every wheel of the vehicle and to calculate the weight of the load received by each shock-absorber of the vehicle and the total weight and loadage of the vehicle; and a display unit electrically coupled to the calculation unit to display the load data of the vehicle.

To achieve this and other objects of the present invention, the intelligent vehicle load measuring method comprises the steps of: (a) installing one sensor in the shock-absorber of every wheel of a vehicle to detect the extension length data of the associating shock-absorber when the vehicle carries a load; (b) using a calculation unit to receive the extension length data of the shock-absorber of every wheel of the vehicle from the installed sensors and to calculate the total weight and loadage of the vehicle; and (c) displaying the load data of the vehicle on a display device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a system block diagram of an intelligent vehicle load measuring system according to the present invention.

FIG. **2** is a schematic drawing showing a mechanical arm type sensor installed in the shock-absorber of one wheel of a vehicle according to the present invention.

FIG. **3** corresponds to FIG. **1**, showing a keypad coupled to the calculation unit.

FIG. **4** is a flow chart of an intelligent vehicle load measuring method according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, an intelligent vehicle load measuring system in accordance with the present invention is shown comprised of at least one, for example, a number of sensors **10**, a calculation unit **20**, and a display device **30**.

The sensors **10** are respectively mounted in the shock-absorber **120** of each wheel **110** of the vehicle to be measured to detect the extension length data of the shock-absorber **120**. The sensors **10** can be, but not limited to, piezoelectric sensors, photo sensors, or variable resistance sensors. According to the present preferred embodiment, each sensor **10** is a mechanical arm. When the vehicle **100** carries a load, the sensors **10** transmit the extension length data of the associating shock-absorbers **120** to the calculation unit **20** by means of a wireless or wired transmission technique.

The calculation unit **20** can be, but not limited to, a microcontroller coupled to the sensors **10** to receive the extension length data of each shock-absorber **120** for calculating the weight of the load received by each shock-absorber **120**. The calculation unit **20** has high-efficiency computing ability. The calculation unit **20** has built therein at least one program (not shown) that controls the calculation unit to calculate the weight received by each shock-absorber **120** subject to Hooke's law and to further calculate the gross (total) weight of the vehicle **100** by means of adding the weight of the wheel system below the shock-absorbers **120** to the sum of the weight received by the shock-absorbers **120**.

The calculation formula of Hooke's law is:

$$W_\gamma = W_O + W_C = W_O + \sum_{i=1}^{m} k_i(\Delta L_i) \quad \text{(Formula I)}$$

in which, W_r is the gross weight of the vehicle **100**; W_O is the net weight of the vehicle **100**; W_C is the weight of the load (the weight of the cargo and persons) carried on the vehicle **100**; k_i is the load constant of i^{th} shock-absorber subject to Hooke's law; ΔL_i is the extension length data of the i^{th} shock-absorber of which the unit of measurement is centimeter; m is the total number of wheels **110** of the vehicle **100** that bear the weight, normally an even number. For example, when the vehicle **100** is a regular sedan, m is 4, and the gross weight of the vehicle **100** is the sum of the net weight of the vehicle **100** (i.e., the empty vehicle weight as specified in the specification provided by the manufacturer) and the load carried on the four wheels **110**.

Further, the calculation unit **20** provides a display mode and a calibration data input mode. When on the display mode, the calculation unit **20** outputs the calculated vehicle total weight data and the data of the weight the load to the display device **30** for display. When on the calibration data input mode, the driver can input a calibration load constant k_i into the calculation unit **20** to assure measurement accuracy. The calibration data input mode matches with a keypad **50** described below, and the detail will be described further.

The display device **30** is coupled to the calculation unit **20** to display weight data relating the vehicle **100**, such as, but not limited to, gross weight of the vehicle **100**, net weight (empty vehicle weight) of the vehicle **100**, loadage of the vehicle **100**, dynamic load on each wheel **110** of the vehicle **100**, maximum transient load, etc. The display device **30** can be, but not limited to, a LCD (liquid crystal display).

Referring to FIG. **2**, the sensor **10** is a mechanical arm connected between the two opposite ends of the associating shock-absorber **120**. When the vehicle **100** carries a load, the shock-absorber **120** is compressed by the weight of the load, and the mechanical arm **10** is forced to project outwards (to reduce its contained angle). The outward projecting distance (the contained angle reducing range) of each sensor **10** varies with the weight of the load, and is indicative of the extension length of the associating shock-absorber **120**. Therefore, the extension length data of every shock-absorber **120** can be obtained and then transmitted to the calculation unit **20** by means of a wireless or wired transmission technique for enabling the calculation unit **20** to calculate the weight received by every shock-absorber **120** and to further calculate the gross weight of the vehicle.

Referring to FIG. **3**, the intelligent vehicle load measuring system further comprises a keypad **50**, which is coupled to the calculation unit **20** for allowing the driver to input a calibration load constant k_i and the net weight of the vehicle W_O into the calculation unit **20** when the calculation unit **20** is on the calibration data input mode, assuring measurement accuracy. The calculation unit **20** and the keypad **50** can be incorporated into a touch screen LCD monitor, thereby saving space.

As stated above, the intelligent vehicle load measuring system has one sensor **10** installed in each shock-absorber **120** of the vehicle **100** to detect the extension length data of every shock-absorber **120** when the vehicle **100** carries a load, and utilizes a calculation unit **20** to calculate the gross weight and loadage of the vehicle **100** and a display device **30** to display the measured data, so that the driver of the vehicle **100** knows the vehicle load data and the pressure bearing status of every shock-absorber **120**. Therefore, the invention eliminates the drawbacks of the prior art techniques.

The invention also provides an intelligent vehicle load measuring method. As shown in FIG. **4**, the intelligent vehicle load measuring method includes the steps of: (a) installing one sensor **10** in the shock-absorber **120** of every wheel **110** of the vehicle **100** to be measured to detect the extension length data of the associating shock-absorber **120** when the vehicle **100** carries a load, (b) using a calculation unit **20** to receive the extension length data of the shock-absorber **120** of every wheel **110** of the vehicle **100** from the installed sensors **10** and to calculate the gross (total) weight and loadage of the vehicle **100**, and (c) displaying the load data of the vehicle **100** on a display device **30**.

In step (a), one sensor **10** is installed in the shock-absorber **120** of every wheel **110** of the vehicle **100** to detect the extension length data of the associating shock-absorber **120** when the vehicle **100** carries a load. The sensors **10** can be, but not limited to, piezoelectric sensors, photo sensors, or variable resistance sensors. According to the present preferred embodiment, each sensor **10** is a mechanical arm. However, the mechanical arm is not a limitation.

In step (b), a calculation unit **20** is used to receive the extension length data of the shock-absorber **120** of every wheel **110** of the vehicle **100** from the installed sensors **10** and to calculate the gross (total) weight of the vehicle **100**. The calculation unit **20** can be, but not limited to, a microcontroller. The calculation unit **20** receives the extension length data of each shock-absorber **120** from the sensors **10** by a wired or wireless communication technique for calculating the weight of the load received by each shock-absorber **120**. The calculation unit **20** has high-efficiency computing ability. The calculation unit **20** has built therein at least one program (not shown) that controls the calculation unit to calculate the weight received by each shock-absorber **120** subject to Hooke's law and to further calculate the gross (total) weight of the vehicle **100** by means of adding the weight of the wheel system below the shock-absorbers **120** to the sum of the weight received by the shock-absorbers **120**.

In step (c), the load data of the vehicle **100** is displayed on a display device **30**. The display device **30** displays the load data of the vehicle **100**, such as, but not limited to, gross weight of the vehicle **100**, net weight (empty vehicle weight) of the vehicle **100**, loadage of the vehicle **100**, dynamic load on each wheel **110** of the vehicle **100**, maximum transient load on each wheel **110** of the vehicle **100**, etc. The display device **30** can be, but not limited to, a LCD (liquid crystal display).

The intelligent vehicle load measuring method further includes step (d) enabling the calculation unit **20** to provide a display mode and a calibration data input mode so that the driver of the vehicle is allowed to input a calibration load constant Ki and the net weight of the vehicle W_O into the calculation unit **20** under the calibration data input mode, assuring measurement accuracy.

As stated above, the intelligent vehicle load measuring method has one sensor **10** installed in each shock-absorber **120** of the vehicle **100** to detect the extension length data of every shock-absorber **120** when the vehicle **100** carries a load, and utilizes a calculation unit **20** to calculate the gross weight and loadage of the vehicle **100** and a display device **30** to display the measured data, so that the driver of the vehicle **100** knows the vehicle load data and the pressure bearing status of every shock-absorber **120**. Therefore, the invention eliminates the drawbacks of the prior art techniques.

Although a particular embodiment of the invention has been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. An intelligent vehicle load measuring system, comprising:

at least one sensor respectively installed in the shock-absorber of every wheel of a vehicle to detect the extension length data of the shock-absorber of every wheel of said vehicle when said vehicle carries a load;

a calculation unit coupled to said at least one sensor to receive the extension length data of the shock-absorber of every wheel of said vehicle and to calculate the weight of the load received by each shock-absorber of said vehicle and the total weight and loadage of the vehicle, said calculation unit is a microcontroller, and said calculation unit provides a display mode for displaying the load data of said vehicle, and a calibration data input mode for input of a calibration load constant;

a display unit electrically coupled to said calculation unit to display the load data of said vehicle; and

a keypad means coupled to said calculation unit for inputting a calibration load constant K_i and the net weight of the vehicle W_o into said calculation unit when said calculation unit is under said calibration data input mode.

2. The intelligent vehicle load measuring system as claimed in claim **1**, wherein each said sensor is selected from the group of piezoelectric sensor, photo sensor, variable resistance sensor and mechanical arm.

3. The intelligent vehicle load measuring system as claimed in claim **1**, wherein each said sensor transmits the detected extension length data of the associating shock-absorber to said calculation unit through a wired connection.

4. The intelligent vehicle load measuring system as claimed in claim **1**, wherein each said sensor transmits the detected extension length data of the associating shock-absorber to said calculation unit through a wireless connection.

5. The intelligent vehicle load measuring system as claimed in claim **1**, wherein said calculation unit has built therein a program that controls said calculation unit to calculate the weight of the load received by each shock-absorber of said vehicle subject to a calculation formula of Hooke's law and to further calculate the total weight of said vehicle by means of adding the net weight of said vehicle to the sum of the weight of the load received by the shock-absorbers of said vehicle.

6. The intelligent vehicle load measuring system as claimed in claim **5**, wherein said calculation formula of Hooke's law is:

$$W_Y = W_O + W_C = W_O + \sum_{i=1}^{m} k_i(\Delta L_i) \quad \text{(Formula I)}$$

in which, W_Y is the gross weight of said vehicle; W_O is the net weight of said vehicle; W_C is the weight of the load including cargo and persons carried on said vehicle; k_i is the load constant of i^{th} shock-absorber subject to Hooke's law; ΔL_i is the extension length data of the i^{th} shock-absorber of which the unit of measurement is centimeter; m is the total number of wheels of said vehicle, which is an even number.

7. The intelligent vehicle load measuring system as claimed in claim **6**, wherein the load data comprises the total weight of said vehicle, the net weight of said vehicle, the loadage of said vehicle, the load received by every wheel of said vehicle and the maximum transient load of every wheel of said vehicle.

8. The intelligent vehicle load measuring system as claimed in claim **1**, wherein said display device is a LCD, and said keypad means is incorporated with said display device into a touch screen LCD monitor.

9. An intelligent vehicle load measuring method, comprising the steps of:

(a) installing one sensor in the shock-absorber of every wheel of a vehicle to detect the extension length data of the associating shock-absorber when said vehicle carries a load;

(b) using a calculation unit to receive the extension length data of the shock-absorber of every wheel of said vehicle from the installed sensors and to calculate the total weight and loadage of said vehicle; and

(c) displaying the load data of said vehicle on a display device;

wherein said calculation unit provides a display mode for displaying the load data of said vehicle, and a calibration data input mode for input of a calibration load constant K_i and the net weight of the vehicle W_O.

10. The intelligent vehicle load measuring method as claimed in claim **9**, wherein each said sensor is selected from the group of piezoelectric sensor, photo sensor, variable resistance sensor and mechanical arm.

11. The intelligent vehicle load measuring method as claimed in claim **9**, wherein each said sensor transmits the detected extension length data of the associating shock-absorber to said calculation unit through a wired connection.

12. The intelligent vehicle load measuring method as claimed in claim **11**, wherein each said sensor transmits the detected extension length data of the associating shock-absorber to said calculation unit through a wireless connection.

13. The intelligent vehicle load measuring method as claimed in claim **9**, further comprising the step of (d) having a program built in said calculation unit for controlling said calculation unit to calculate the weight of the load received by each shock-absorber of said vehicle subject to a calculation formula of Hooke's law and to further calculate the total weight of said vehicle by means of adding the net weight of said vehicle to the sum of the weight of the load received by the shock-absorbers of said vehicle.

14. The intelligent vehicle load measuring method as claimed in claim **13**, wherein said calculation formula of Hooke's law is:

$$W_Y = W_O + W_C = W_O + \sum_{i=1}^{m} k_i(\Delta L_i) \quad \text{(Formula I)}$$

in which, W_Y is the gross weight of said vehicle; W_O is the net weight of said vehicle; W_C is the weight of the load including cargo and persons carried on said vehicle; k_i is the load constant of i^{th} shock-absorber subject to Hooke's law; ΔL_i is the extension length data of the i^{th} shock-absorber of which the unit of measurement is centimeter; m is the total number of wheels of said vehicle, which is an even number.

15. The intelligent vehicle load measuring method as claimed in claim **14**, wherein the load data comprises the total weight of said vehicle, the net weight of said vehicle, the loadage of said vehicle, the load received by every wheel of said vehicle and the maximum transient load of every wheel of said vehicle.

16. The intelligent vehicle load measuring method as claimed in claim **9**, wherein said calculation unit is a microcontroller.

17. The intelligent vehicle load measuring method as claimed in claim **9**, wherein said display device is a LCD.

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